

FINAL REPORT - TASK 16

February, 1970 to October, 1970

## DEVELOPMENT OF FREEZE DRIED VEGETABLES

Contract NAS 9-9032

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FINAL REPORT  
Development of Freeze Dried Vegetables  
Contract NAS 9-9032  
Task 16  
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ABSTRACT

This report covers the development of freeze dried vegetables to be used in the Apollo Food System. After the initial selection and screening of vegetables, several types of freeze dried vegetables were prepared in small batches. From these small batches, two vegetables were judged satisfactory for further testing and evaluation. These vegetables, mashed potatoes and asparagus, were subjected to storage at  $100^{\circ} \pm 5^{\circ}\text{F.}$  for two (2) weeks and then taste tested. The vegetables were also tested to determine if they complied with the microbiological requirements for Apollo food. Thirty (30) servings of each vegetable developed was submitted to NASA. The Space Food Prototype Production Guide for the vegetables is submitted as part of this report.

OBJECTIVE

The objective of this task was to develop at least two (2) new types of dehydrated vegetables that could be used in the Apollo Feeding System. For this task only fresh vegetables were to be used. After dehydration, the vegetables were to be vacuum packed in aluminum foil plastic laminated pouches and stored for two (2) weeks at  $100^{\circ} \pm 5^{\circ}\text{F.}$  Upon completion of storage, each vegetable was to be taste evaluated to determine if it had undergone any appreciable changes. Thirty (30) servings of each acceptable vegetable was to be sent to NASA for evaluation.

APPROACH

The first step in the task was the selection of the types of fresh vegetables

APPROACH (Continued)

to be dehydrated and to determine if they would be acceptable additions to the Apollo menu. The vegetables were selected on the basis of familiarity and physiological acceptance and upon the freeze-thaw characteristic, that is, could they be frozen and thawed without losing all textural qualities. It was also decided that the new vegetable items were to be formulated without sauces.

After the selection of the types of vegetables to be dried was made, trial cooking methods and formulations were developed and the products were freeze dried. The dried experimental sized batches of vegetables were evaluated for flavor, texture, etc. Where necessary, further adjustments were made in the variety of vegetable used or in the cooking and formulations procedure and new batches of vegetables were dried and taste evaluated. After acceptable formulation had been developed, a sample of each type of dried vegetable was vacuum packed in aluminum foil laminated plastic pouches. The samples of vegetables were then stored for two (2) weeks at  $100 \pm 5^{\circ}\text{F}$ . Upon completion of the two (2) weeks storage, samples were taste evaluated to determine if they had undergone any appreciable loss in taste characteristics during storage. Unstored products were tasted at the same time as the stored sample and were used for comparison. Tasters rated the overall quality of the products and noted if there was any difference between the two samples.

Samples of the vegetables passing taste testing after storage, were evaluated to determine if they complied with the requirements of Addendum No. 1, Microbiological Requirements for Space Food Prototype.

Finally, a batch of each of the vegetables passing the above test was prepared, packaged and shipped to NASA/MSC for evaluation.

## RESULTS

The vegetables selected for initial development were:

Mashed White Potatoes  
Mashed Sweet Potatoes  
Asparagus  
Broccoli  
Spinach  
Green Beans

Experimental batches of each of the above vegetables were made using several different cooking procedures and seasoning formulations. Rehydration and taste evaluation of the several batches of each vegetable showed that:

- 1) The mashed sweet potatoes were difficult to rehydrate and had a poor texture.
- 2) Broccoli heads (florets) were too fragile to remain on the stem during rehydration and that it had poor, mushy texture and poor flavor.
- 3) The spinach had a poor appearance and flavor.
- 4) Green Beans had a poor texture, flavor and appearance.
- 5) The dried mashed potatoes and the dried asparagus were found to have a satisfactory texture and flavor.

Samples of the dried potatoes and asparagus were vacuum packed in flexible plastic laminated pouches and stored for two (2) weeks at  $100 \pm 5^{\circ}\text{F}$ . Upon completion of the storage, samples were tested and compared with unstored samples by an informal panel. The panel found that neither of these two vegetables had undergone any appreciable change during the high temperature storage. Samples of the dried mashed potatoes and the dried asparagus were also subjected to microbiological evaluations according to Addendum No. 1, Microbiological Requirements for Space Food Prototypes and were found to comply with this document.

Thirty (30) servings of dried mashed potatoes and asparagus were submitted to NASA/MSC for evaluation. A Space Food Prototype Production Guide for the

#### RESULTS (Continued)

above products has been written and is included in this report as Attachment 1.

#### CONCLUSION

Two (2) freeze dried vegetables were developed and thirty (30) servings of each have been submitted to NASA for evaluation. Each of the vegetables meet the requirements of the Addendum No. 1, Microbiological Requirements for Space Food Prototypes. None of the vegetables submitted had undesirable taste characteristics after two (2) weeks of storage at  $100^{\circ} \pm 5^{\circ}\text{F}$ .

The work also showed that the development of freeze dried vegetables without sauces for space food is not simple. It appears that a more basic development effort is required, such as chemical pretreatment of vegetables prior to freezing and the evaluation of the effect of different varieties on the quality of the freeze dried product, etc.

VEGETABLES, DEHYDRATED

1.0 SCOPE

1.1 Scope

This Production Guide covers the manufacturing of dehydrated vegetables for use in aerospace feeding.

1.2 Classification

The product shall be of the following types as specified, (See 6.1):

Type I - Mashed White Potatoes

Type II - Asparagus

2.0 APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

STANDARDS

Federal

Federal Test Method Standard No. 101-Preservation, Packaging and Packing Materials: Test Procedures.

United States Standards for Grades of Frozen Asparagus.

Military

MIL-STD-668                      Sanitary Standards for Food Plants

NASA

ADDENDA TO SPACE FOOD PROTOTYPE PRODUCTION GUIDES

Addendum No. 1    -    Microbiological Requirements for Space Food Prototypes.

Addendum No. 2    -    Quality Assurance Provisions.

(Copies of specifications and standards required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

## 2.2 Other Publications

The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids or request for proposal shall apply:

### U.S. Department of Health, Education, and Welfare

Federal Food, Drug and Cosmetic Act and Regulations Promulgated Thereunder. (Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.)

### Association of Official Analytical Chemists

Official Methods of Analysis. (Application for copies should be addressed to the Association of Official Analytical Chemists, Box 540, Benjamin Franklin Station, Washington, D.C. 20044.)

## 3.0 REQUIREMENTS

### 3.1 Pre-Award Sample

When specified, (See 7.1), a sample of the product the supplier proposes to furnish shall be submitted for use in evaluating bids or proposals. The sample shall be packaged, labeled, packed, and marked in accordance with Section 5, and submitted as instructed by the contracting officer. Sample evaluation will be based on compliance with the applicable requirements of 4.4. When a sample is required, the quantity will also be specified.

### 3.2 First Article

When specified, (See 7.1), a sample of the product shall be submitted to the contracting officer for approval before production commences. This sample shall be representative of the product the supplier proposes to furnish under the contract. Sample approval will be based on compliance with the applicable requirements of 4.4. When a sample is required, the quantity will also be specified.

### 3.3 Materials (All Types)

All ingredients and materials shall be clean and free from foreign material, foreign odor, foreign color and foreign flavor.

- 3.3.1 Asparagus. The asparagus shall be of a common commercial variety, harvested at a state of maturity judged to meet U.S. Grade A quality specifications for frozen asparagus.
- 3.3.2 Salt (NaCl). The salt shall be non-iodized, white refined sodium chloride with or without anticaking agents.
- 3.3.3 Mono Sodium Glutamate (MSG). MSG shall be food grade or better; white, practically odorless, free-flowing crystals or crystalline powder and labeled not less than 99% MSG.
- 3.3.4 Potatoes. The potatoes shall be of a common commercial variety that yields a mashed potato that is not lumpy. They shall be U.S. Number 1 potatoes that are in excellent condition at the time of use.
- 3.3.5 Butter. The butter shall be labeled U.S. Grade A and be in excellent condition at the time of use.
- 3.3.6 Milk. Fresh, homogenized, whole milk that is labeled U.S. Grade A shall be used.
- 3.3.7 Nitrogen. The nitrogen shall be labeled USP Grade and be water or liquid nitrogen pumped.

3.4. Processing

Components complying with 3.3 shall be processed in accordance with 3.4.1 through 4.3.

- 3.4.1 Formula. The product formulation shall be in accordance with Table I.

TABLE I  
PRODUCT FORMULA

Ingredients	Quantity (Percent by Weight)	
	Type I	Type II
Asparagus		100
Potatoes	75.55	
Milk	19.59	
Butter	4.55	
Salt	.31	
	100.00%	100%



#### 4.0 PREPARATION

##### 4.1 Type I

The potatoes shall be washed and scrubbed to remove all dirt and soil. The potatoes shall be placed in enough water to cover and shall be boiled until tender. After cooking, peel skin and other dark areas. Next, the potatoes shall be mashed either by hand or in an electric mixer. After mashing, the milk, butter and salt shall be added and the mixture shall be whipped in an electric mixer until smooth.

##### 4.2 Type II

The asparagus shall be washed with cold water and the tough butt ends removed. The asparagus shall next be cut into 2 to 3 inch pieces. After cutting, the asparagus shall be soaked for one (1) hour in a 1% salt (NaCl) solution. After soaking, the asparagus shall be rinsed and drained. Next, the asparagus shall be cooked in a seasoned cooking water for  $13 \pm 2$  minutes. The seasoned cooking water is composed by 1% salt (NaCl) concentration with 0.6 gm. MSG added per pound of asparagus. The ratio of cooking water to asparagus shall be 1 lb. of asparagus to 1.1 lbs. of water. After cooking, the asparagus shall be drained and placed in freeze drier trays.

##### 4.3 Freeze Drying

Freeze dehydration shall be at a maximum pressure of 1.0 mm. Hg. and a maximum temperature of the dry product of 120°F. The dehydrator vacuum shall be broken with nitrogen, (See 3.3.7).

##### 4.4 Finished Product

The finished product shall comply with the requirements of 4.4.1, 4.4.2 and Table II, which are applicable to the type of product specified.

4.4.1 Moisture. The finished product shall have a moisture content of not greater than 3.0 percent, (See 5.2.1).

- 4.4.2 Microbiological. This finished product shall comply with the requirements specified in Addendum No. 1, Microbiological Requirements for Space Food Prototypes.
- 4.4.3 The product shall be processed in establishments meeting the sanitary requirements of MIL-STD-668.
- 4.4.4 All deliveries shall conform in every respect to the provisions of the Federal Food, Drug and Cosmetic Act and Regulations Promulgated Thereunder.

TABLE II  
FINISHED PRODUCT REQUIREMENTS

Item No.	Requirements
<u>Dehydrated Product</u>	
1	There shall be no foreign odor, such as but not limited to burnt, scorched, stale, sour, rancid, musty or moldy odor.
2	There shall be no foreign material, such as but not limited to dirt, insect, insect part, wood, paper, paint, glass or metal.
3	There shall be no foreign color such as but not limited to purple, blue or red.
4	The product weight per serving shall be as given below:
	<u>Weight</u>
	Type I 27.0 $\pm$ 1.0 gms.
	Type II 8.4 $\pm$ 0.2 gms.
5	There shall be no evidence of incomplete dehydration such as soft or soggy areas.
6	There shall be no evidence of faulty dehydration such as glazed areas or dark cores.
<u>Rehydrated Product</u>	
7	Type I product shall rehydrate in 3 oz. of water within 10 minutes or Type II product shall rehydrate in 2 oz. of water when tested in accordance with Addendum No. 2, Quality Assurance Provisions.
8	The product shall have an acceptable flavor, odor, and texture when tested in accordance with Addendum No. 2, Quality Assurance Provisions.

## 5.0 QUALITY ASSURANCE PROVISIONS

- 5.1 Quality Assurance Provisions shall be in accordance with Addendum No. 2.

## 5.2 Tests

### 5.2.1 Moisture. The analysis for moisture content shall be as follows:

- a) Weigh two (2) samples of approximately 2 grams each of ground finished product into tared, dry aluminum dishes (approximately 2 to 2-1/2 inches in diameter and 3/4 inches in depth) with tight fitting covers.
- b) Place the dishes, with cocked lids, in a vacuum oven for 16 hours at 70°C. under a pressure of not more than 50 mm. of mercury. During drying, admit to the oven a slow current of air (approximately 2 bubbles per second) dried by passing through concentrated sulfuric acid.
- c) Remove the dishes; close the lids and allow to cool to room temperature in a desiccator; then weigh.
- d) Calculate the percent moisture by dividing the weight loss by the original sample weight and multiplying by 100. The average of the duplicate samples shall be reported to the nearest 0.1 percent.

### 5.2.2 Headspace Oxygen. The oxygen content shall be determined in accordance with method 237 of Fed. Std. No. 101 - Preservation, Packaging, and Packing Materials: Test Procedures. The oxygen content shall be reported to the nearest 0.1 percent.

### 5.2.3 Microbiological. The finished product shall be tested in accordance with Addendum No. 1, Microbiological Requirements for Space Food Prototypes.

## 6.0 PREPARATION FOR DELIVERY

### 6.1 Packaging

After dehydration, the product shall be immediately packaged in accordance with 6.1.1 or 6.1.2..

#### 6.1.1 Interim Packaging in Cans. The finished product shall be filled into cans of any convenient size. The cans shall be evacuated and flushed with nitrogen

6.1.1 (continued)

enough times so that the headspace gas contains not more than 2.0 percent oxygen, (See 5.2.2). Cans shall be held at not more than 50°F. until packaged in accordance with 6.1.2. When interim packaging is to be used for shipping, the item shall be layered tightly within the cans to prevent shifting. Suitable padding shall be included between the product and the cans to prevent damage to the contents.

6.1.2 Flexible Packages. The product shall be filled into the flexible material specified.

6.2 Labeling, Packaging and Marking

Assembly and subassembly documents will contain the detailed instructions for labeling, intermediate packaging, packing and marking. However, when the product is to be shipped other than as part of a subassembly or assembly, (See 7.1), labeling, packaging and marking shall be in accordance with 6.2.1 through 6.2.3.

6.2.1 Labeling. The following information shall appear on the label glued to the package:

- a. Name of product
- b. Number of this document
- c. Number of pieces and net weight
- d. Date of manufacture
- e. Name of manufacturer
- f. Lot Number
- g. Contract or proposal number

6.2.2 Packing. The cans or flexible packages shall be packed and sealed (glue or tape) in a fluted fiberboard box. The contents shall be prevented from shifting by a tight fit or by padding.

6.2.3 Marking. The following information shall appear on a label or be marked on the box:

- a. Name and address of addressee
- b. Name and address of addressor
- c. An attention line
- d. The words FRAGILE or HANDLE WITH CARE

7.0 NOTES

7.1 Ordering Data

Purchasers should exercise any desired options offered herein and procurement documents should specify the following:

- a. Title, number, and date of this document.
- b. Type of product required, (See 1.2).
- c. The packaging materials required, (See 6.1.2).
- d. When pre-award sample is to be furnished and the quantity, (See 3.1).
- e. When first article sample is to be furnished and the quantity, (See 3.2).
- f. When product is to be shipped as other than assembly or subassembly, (See 6.2).